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NATIONAL DAM SAFETY PROGRAM. BURTON-DUENKE DAM NUMBER 5 (MO 316--ETC(U)
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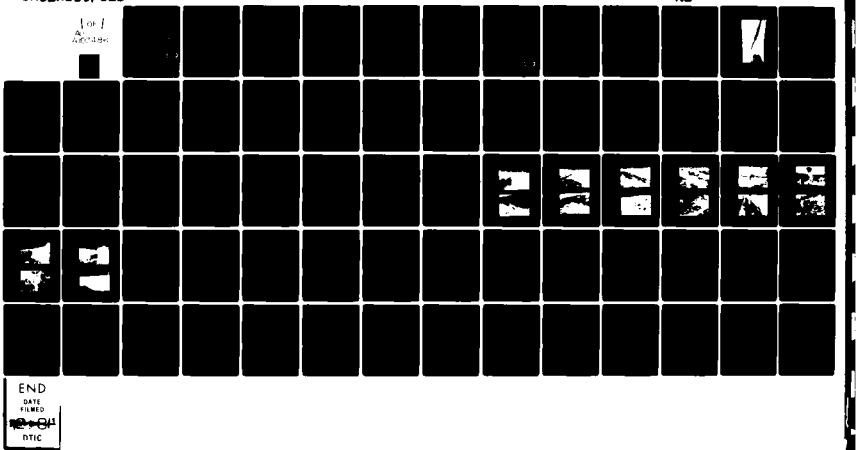

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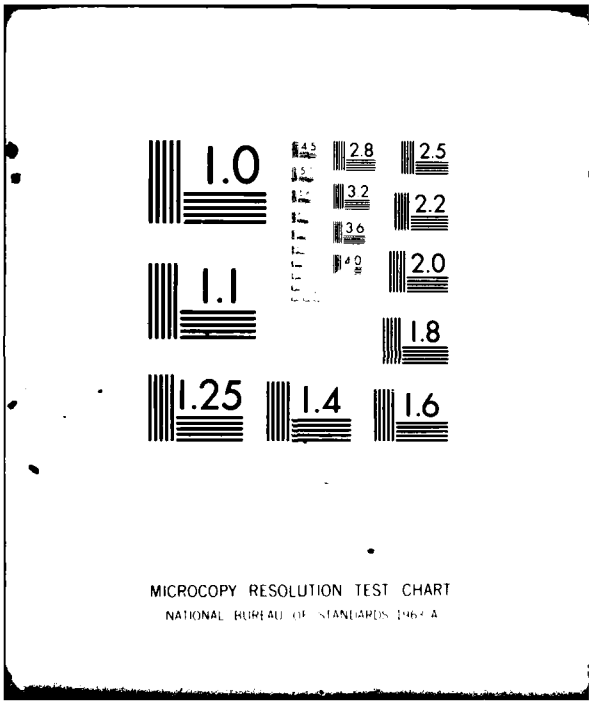
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MISSOURI-OSAGE-GASCONADE BASIN

AD A107486

BURTON-DUENKE DAM #5
CAMDEN COUNTY, MISSOURI
MO 31608

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

APRIL 1981

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4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Burton-Duenke Lake No. 5 (MO 31608) Camden County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report
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7. AUTHOR(s) Black & Veatch, Consulting Engineers	8. CONTRACT OR GRANT NUMBER(s) DACW43-81-C-0037
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES

Edwin R. /Burton Harry L. /Callahan

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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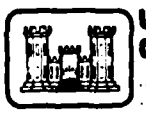
MISSOURI-OSAGE-GASCONADE BASIN

BURTON-DUENKE DAM #5

CAMDEN COUNTY, MISSOURI

MO 31608

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

APRIL 1981

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Burton-Duenke Dam #5 (MO 31608).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED 17 JUL 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED 20 JUL 1981
Colonel, CE, Commanding — Date

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BURTON-DUENKE DAM #5

CAMDEN COUNTY, MISSOURI

MISSOURI INVENTORY NO. 31608

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

APRIL 1981

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Burton-Duenke Dam #5
State Located	Missouri
County Located	Camden County
Stream	Tributary of the Lake of the Ozarks
Date of Inspection	23 April 1981

Burton-Duenke Dam #5 was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately one mile downstream to the Lake of the Ozarks. Within the estimated damage zone are thirteen trailers, a marina, boat docks, and two dwellings. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass the probable maximum flood without overtopping but will pass 15 percent of the probable maximum flood. The spillway will pass the flood which has a one percent chance of occurrence in any given year (100-year flood). The spillway design flood recommended by the guidelines is the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were seepage on the downstream slope, at the toe, and on both abutments, erosion on the upstream and downstream slopes and at the interface of the right abutment and the upstream slope, small trees on the upstream

and downstream slopes, the very thin ground cover and poor drainage on the crest. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Edwin R. Burton, PE
Missouri E-10137

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BURTON-DEUNKE DAM #5

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Burton-Duenke Dam #5 be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary to the Lake of the Ozarks (see Plate 1). The watershed is an area of steep hills consisting of about 75 percent timber and 25 percent grassland. The grassland consists of maintained fairways and greens. There is very little underbrush in the areas of timber. The dam is approximately 450 feet long along the crest and 43 feet high. The dam crest is 49 feet wide. The downstream face of the dam has a uniform slope from the crest to the valley floor below.

(2) The spillway is an uncontrolled 18-inch corrugated metal pipe installed in the embankment. The owner's representative, Mr. Wes Westhoff stated that the pipe has metal pipe collars. The pipe acts as an orifice. Flow through the pipe discharges into a ditch and then to the hillside. There is no emergency spillway. Well water is pumped into the lake through a valved 2-inch plastic pipe.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in northeast Camden County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an area shown on the United States Geological Survey 7.5 minute series quadrangle map for Lake Ozark, Missouri in Section 9 of T39N, R16W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the Burton-Duenke Dam #5 which has a height of 43 feet and a normal storage capacity of 32 acre-feet, is in the intermediate size category. An intermediate size dam is classified as having a height less than 100 feet, but greater than or equal to 40 feet and/or a storage capacity less than 50,000 acre-feet, but greater than or equal to 1,000 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Burton-Duenke Dam #5 has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Burton-Duenke Dam #5 the estimated flood damage zone extends approximately one mile downstream to the Lake of the Ozarks. Within the estimated damage zone are thirteen trailers and two dwellings. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by the Burton-Duenke Development Company, P. O. Box 213-32, Osage Beach, Missouri 65065.

f. Purpose of Dam. The dam forms a 2.6-acre lake used for recreation.

g. Design and Construction History. The owner's representative, Mr. Wes Westhoff, stated that the dam was designed by Mr. Dave Krehbiel and was constructed in 1972. Mr. Westhoff stated that the dam was constructed with a bulldozer with the embankment material dumped in 15 cubic yard quantities. No other data relating to the design and construction were available.

h. Normal Operating Procedure. Under normal operation, rainfall, runoff, transpiration, evaporation, overflow through the uncontrolled spillway, the rate of pumping into the lake, and the rate of seepage through the embankment will combine to maintain a relatively stable water surface elevation. The owner's representative stated that the lake had never been full.

1.3 PERTINENT DATA

a. Drainage Area - 28 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled 18-inch corrugated metal pipe.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 12 cfs (Probable Maximum Flood Pool El. 783.5).

c. Elevation (Feet above m.s.l. approximate tie to USGS map).

(1) Top of dam - 782.5 (see Plate 3)

(2) Spillway inlet invert - 780.0

(3) Streambed at toe of dam - 739.1

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 700 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 600 feet ± (Spillway inlet invert)

e. Storage (Acre-feet).

(1) Top of dam - 39

(2) Spillway inlet invert - 32

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 3.3

(2) Spillway inlet invert - 2.6

g. Dam.

(1) Type - Earth embankment

(2) Length - 450 feet

(3) Height - 43 feet ±

(4) Top width - 49 feet

(5) Side slopes - upstream face 1.0 V on 1.9 H, downstream face 1.0 V on 2.4 H (see Plate 4).

(6) Zoning - Unknown.

(7) Impervious core - Mr. Westhoff stated that the dam has a clay core.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Spillway.

(1) Type - 18-inch corrugated metal pipe.

(2) Inlet invert elevation - 780.0 feet m.s.l.

(3) Outlet invert elevation - 778.8 m.s.l.

(4) Gates - None.

(5) Upstream channel - None. The watershed consists of a wooded hillside on a golf course.

(6) Downstream channel - Discharges to a ditch and then to the hillside.

j. Emergency Spillway - None.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The dam was designed by Mr. Dave Krehbiel.

2.2 CONSTRUCTION

Construction records were unavailable, however, the owner's representative stated that the dam was constructed in 1972. He also stated that the dam was constructed with a bulldozer with the embankment material dumped in 15 cubic yard quantities.

2.3 OPERATION

Operational records and documentation of past floods were unavailable. Well water is pumped into the lake through a valved 2-inch plastic pipe.

2.4 GEOLOGY

The site of the dam and reserovir is located in a narrow, steep-sided valley in hilly terrain. The dam impounds a small intermittent side tributary of the Osage River which is dammed to form the Lake of the Ozarks.

The soils in the area of the dam and reservoir consist of the Lebanon, Doniphan, Gepp, Bardley and Clarksville soil series. The Lebanon soils are formed in loess overlying residuum weathered from cherty limestone or dolomite on ridgetops and upper side slopes. For engineering purposes the soils are classified as CL material. The Doniphan soils are formed in residuum weathered from clayey shales and cherty dolomite on ridgetops and sideslopes. For engineering purposes the soils are classified as CL, CH, MH, GM, or SM-SC materials. The Gepp, Bardley and Clarksville soils are developed in residuum weathered from cherty dolomite. For engineering purposes the soils are classified as GC, GM, SC, SM, ML, CL or CH materials depending on location of the samples.

The bedrock in the area of the dam and reservoir consists of dolomite with abundant chert of the Gasconade formation of the Canadian Series of the Ordovician System. The Gasconade formation forms nearly vertical bluffs and cliffs along streams in the central Ozarks and caves and springs are common.

2.5 EVALUATION

a. Availability. No engineering data were available.

b. Adequacy. No engineering data were available. Thus, an assessment of the design, construction, and operation could not be made. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Burton-Duenke Dam #5 was made on 23 April 1981. The inspection team consisted of Edwin Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and John Ruhl, hydrologic/hydraulic engineer. Mr. Westhoof and Mr. Krehbiel, representatives of the owner, met the inspection team at the dam and provided information regarding design, construction and maintenance. The dam appears to be in less than satisfactory condition due to seepage conditions. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. No cracking, sliding, sloughing, sinkholes or other signs of settlement or instability were observed. The upstream slope of the embankment is fairly steep. No toe drains, relief wells or instruments to measure the performance of the dam were located.

The entire downstream slope from about two feet below the water level to the toe was very soft and wet from seepage. There were no areas where flow from seepage was observed. Cattails were growing at the toe and at the abutments as a result of the seepage.

Erosion of silty clay material is occurring on the upstream and downstream slopes and at the interface of the right abutment and the upstream slope. Runoff from the crest has caused the gullies on the upstream slope. Poor drainage of the crest between the golf cart path and the top of the downstream slope had resulted in standing water from rain on the day previous to the inspection. New material has been dumped over the principal spillway pipe, but this was assumed to be repair of erosion caused by local runoff from the hillside above the left abutment. Approximately one dump load of this material has been deposited on the dam crest. There is no evidence to indicate that the embankment has ever been overtopped.

The ground cover on the embankment consists of thin grass and weeds. The soil is rocky with rock fragments ranging in size from fine gravel to 2 to 3 inches. A few dogwood, oak, hickory, and sycamore trees (1/2 to 1 inch in diameter) were growing on the upstream and downstream slopes. There was no rip rap present on the upstream face. A few willows were growing at the toe of the embankment. There were no animal burrows observed.

c. Appurtenant Structures. The spillway was the only appurtenant structure observed by the inspection team. The alignment of the spillway pipe was viewed from the upstream end. The pipe bends to the right at

about the midpoint and is crimped at the bend. There was no trash rack at the pipe inlet. The outlet end is approximately 95 percent filled with dumped earth material. About 3 to 4 feet of the outside of the pipe was observed from the upstream end. No pipe collars were observable. The pipe appears to be in good condition with no rust observed. There is no evidence of leakage into, out of , or around the pipe. The spillway pipe discharges into a ditch which is approximately 2 feet wide and 2 feet deep. The ditch ends about 60 feet below the pipe outlet where discharge is released to the hillside. Minor erosion has taken place downstream of the pipe outlet.

d. Geology. The soils in the area of the dam and reservoir consist of silty clay with numerous rock fragments ranging in diameter from 1/4 inch to 6 inches. The soil developed in residuum weathered from the underlying dolomite and chert bedrock. The soil is typically less than 5 feet thick.

The bedrock in the area of the dam and reservoir consists of dolomite and chert of the Gasconade formation. Outcrops of cherty dolomite were observed along the slopes downstream of the embankment. The bedding is horizontal and massive with open bedding planes. Widely spaced vertical joints in the rock are oriented N80°W and at 45° to the embankment. The abutments and foundation are anticipated to consist of dolomite and chert.

Samples of the near surface materials in the embankment were taken near the upstream crest of the embankment with an Oakfield sampler. The materials were classified as silty clay with numerous chert rock fragments. For engineering purposes the samples were classified as CL materials. Based on these samples, it is anticipated that the remainder of the embankment is constructed of similar materials.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The lake was fairly clear with no noticeable siltation and a visibility of 1-1/2 to 2 feet.

f. Downstream Channel. The spillway discharges to a ditch and then to the hillside. The natural stream channel is at the opposite end of the embankment.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control.

The extensive seepage observed on the downstream slope should be monitored regularly for quality and quantity. Similar areas of seepage were observed in natural hillsides in the area, including some above the lake level, with no adverse effects. Seepage can cause internal erosion, creating cavities and underground channels, thereby weakening the embankment. The erosion gullies should be backfilled with suitable material and compacted. Material should be placed in the low area on the crest to prevent standing water. The spillway pipe may be susceptible to clogging due to its bent alignment. Realignment of the spillway pipe or constructing an inlet baffle would reduce the potential for clogging. The embankment should be seeded to prevent erosion, particularly on the upstream face. No wave action was observed during the inspection, therefore, seeding for a dense, grass cover will be adequate to protect the upstream slope from erosion. The trees on the embankment should be removed. The roots of trees can loosen the embankment material and also can leave voids through which water can pass.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Under normal conditions the pool will be primarily controlled by rainfall, runoff, evaporation, transpiration, capacity of the uncontrolled spillway, the rate of pumping into the lake, and the rate of seepage through the embankment. The owner's representative stated that the lake had never been full.

4.2 MAINTENANCE OF DAM

There was no evidence of a regular maintenance program. The crest has been graded and additional material has been dumped on it.

4.3 MAINTENANCE OF OPERATING FACILITIES

There has been no known maintenance to the plastic pipe and valve.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be established to include seeding the embankment with grass, mowing the grass and weed cover on the embankment when it is developed and removal of trees.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available.

b. Experience Data. The drainage area and lake surface area are developed from the USGS Lake Ozark Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The spillway is in less than satisfactory condition. The lake level at the time of the inspection (El. 776.3) was below the spillway inlet invert level. The pipe was about 95 percent filled with dumped earth material at the outlet end at the time of the inspection. There were no obstructions to flow in the downstream channel.

(2) There is no emergency spillway for this dam.

(3) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway will pass 15 percent of the probable maximum flood without overtopping the dam. The spillway will pass the one percent chance flood estimated to have a peak outflow of 8 cfs developed by a 24-hour, one percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of intermediate size should pass the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 320 cfs of the total discharge from the reservoir of 331 cfs. The estimated duration of overtopping is 5.5 hours with a maximum height of 0.7 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 652 cfs of the total discharge from the reservoir of 664 cfs. The estimated duration of overtopping is 8.1 hours with a maximum height of 1.0 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately one mile downstream to the Lake of the Ozarks. Thirteen trailers, a marina, boat docks, and

two dwellings could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated downstream damage zone were verified by the inspection team. There does not appear to be any flood plain regulations or other constraints in force to limit future downstream development.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. The only postconstruction changes which were observed are the grading on the crest and the additional material which has been dumped on it. When these repairs were made is unknown.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are seepage on the downstream slope, at the toe, and on both abutments, erosion on the upstream and downstream slopes and at the interface of the right abutment and the upstream slope, small trees on the upstream and downstream slopes, the very thin ground cover and poor drainage on the crest. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the absence of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The spillway size and/or storage volume would need to be increased or the lake level would need to be permanently lowered to increase available flood storage in order to effectively pass

the recommended spillway design flood. Spillway capacity could be increased by providing an emergency spillway. The storage volume could be increased by raising the low areas of the dam crest.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) The seepage area noted during the visual inspection should be closely monitored and documented as to quantity of flow. Any significant changes should be evaluated.

(2) The erosion gullies on the upstream and downstream slopes and at the interface of the right abutment and the upstream slope should be backfilled with suitable material and compacted. The backfilled material should be seeded to provide added protection against erosion in the future. Material should be placed in the low area on the crest to prevent standing water.

(3) A maintenance program to remove and control the growth of trees on the embankment should be developed. The embankment should be seeded with grass. Grass/ weed cover on the embankment should be cut periodically after it has been developed.

(4) Seepage and stability analyses should be performed.

(5) It is recommended that a debris baffle or trash rack be installed at the spillway pipe inlet.

(6) A detailed inspection of the dam should be made periodically. The findings of this inspection should be documented and made a matter of record. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

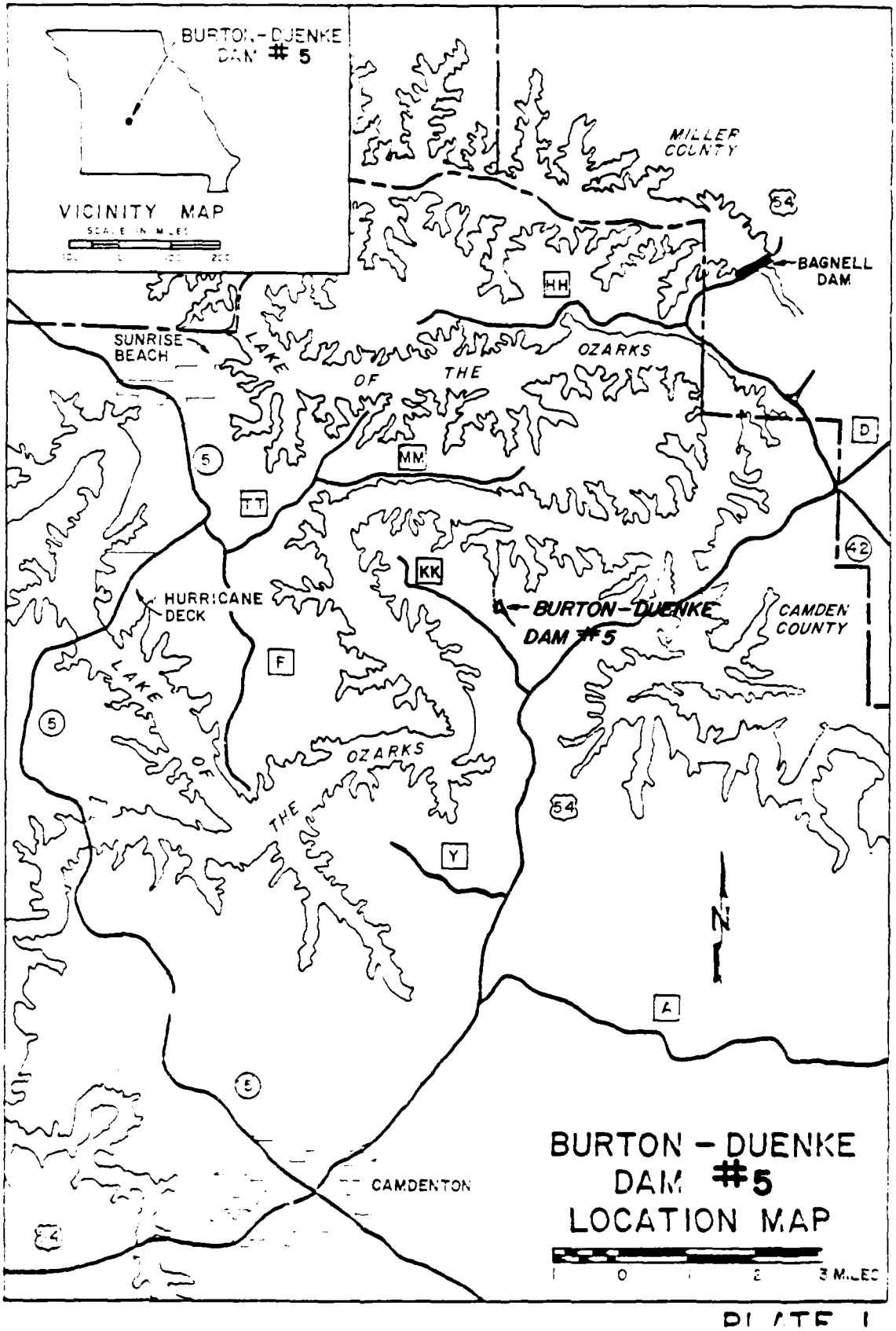
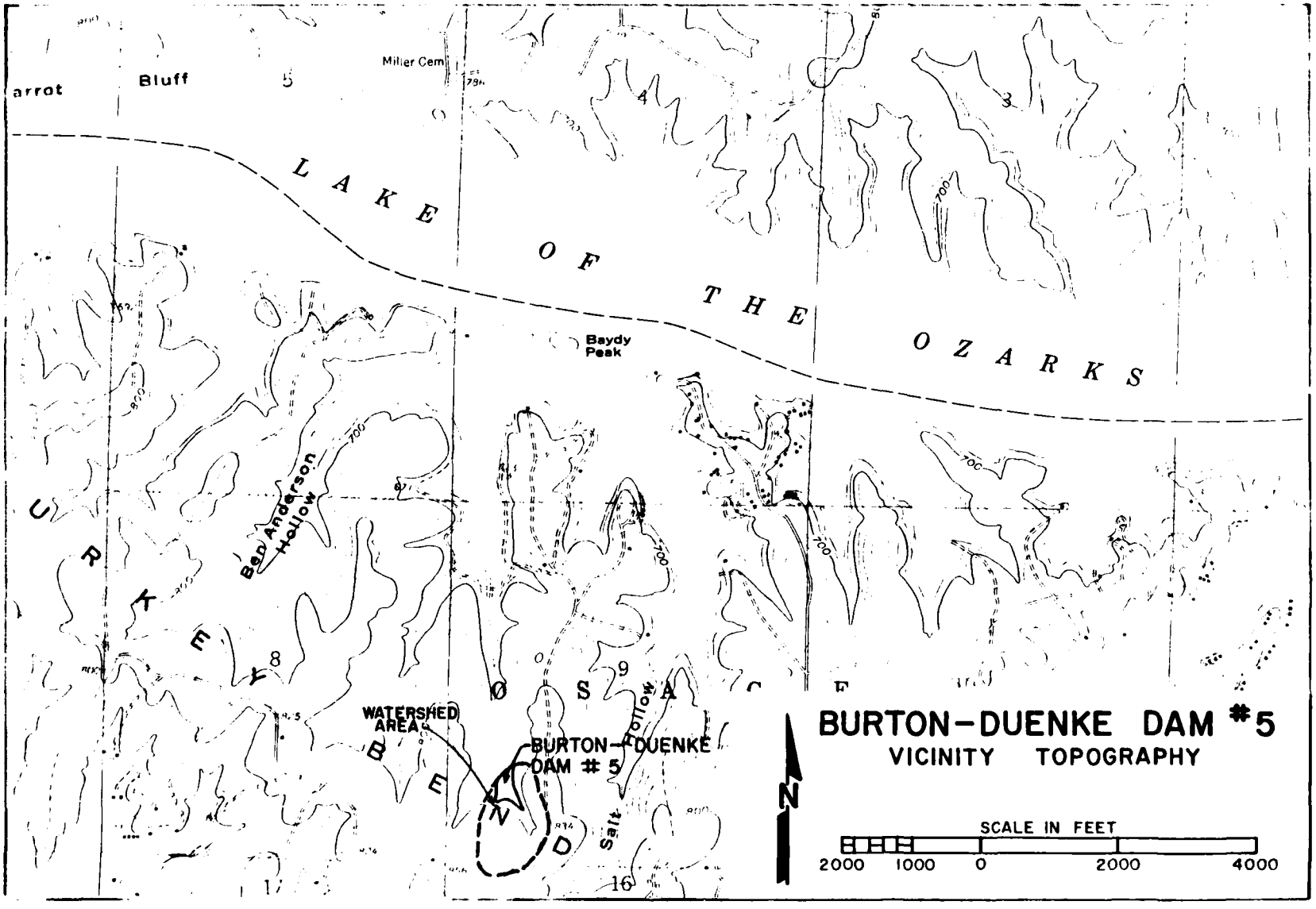

BURTON-DUENKE DAM # 5
VICINITY MAP
MILLER COUNTY
54
BAGNELL DAM
HH
SUNRISE BEACH
LAKE OF THE OZARKS
D
5
MM
TT
42
KK
HURRICANE DECK
BURTON-DUENKE DAM #5
CAMDEN COUNTY
F
LAKE OF THE OZARKS
54
Y
N
A
5
CAMDENTON
BURTON - DUENKE DAM #5 LOCATION MAP
0
1
2
3 MILES

PLATE 1

PLATE 2


arrat
Bluff
Miller Cem
LAKE OF THE OZARKS
Baydy Peak
Big Anderson Hollow
TURKEY
WATERSHED AREA
BURTON-DUENKE DAM #5
Salt Hollow
BEND
BURTON-DUENKE DAM #5
VICINITY TOPOGRAPHY
N
SCALE IN FEET
2000 1000 0 2000 4000

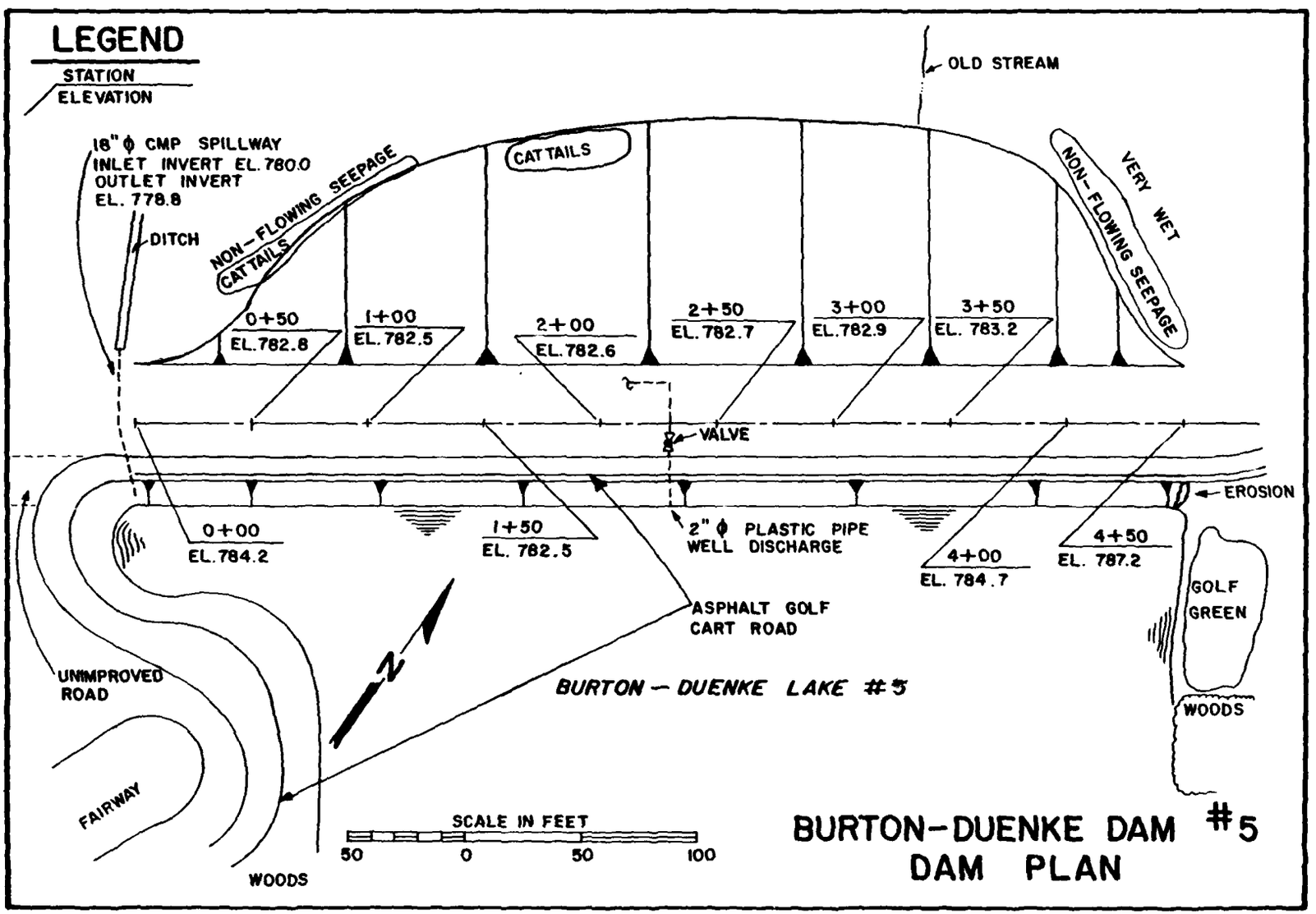

LEGEND
STATION
ELEVATION
OLD STREAM
18" ϕ CMP SPILLWAY
INLET INVERT EL. 780.0
OUTLET INVERT
EL. 778.8
DITCH
NON-FLOWING SEEPAGE
CAT TAILS
CAT TAILS
NON-FLOWING SEEPAGE
VERY WET
0+50
EL. 782.8
1+00
EL. 782.5
2+00
EL. 782.6
2+50
EL. 782.7
3+00
EL. 782.9
3+50
EL. 783.2
VALVE
EROSION
0+00
EL. 784.2
1+50
EL. 782.5
2" ϕ PLASTIC PIPE
WELL DISCHARGE
4+00
EL. 784.7
4+50
EL. 787.2
GOLF
GREEN
ASPHALT GOLF
CART ROAD
UNIMPROVED
ROAD
BURTON - DUENKE LAKE #5
WOODS
FAIRWAY
WOODS
SCALE IN FEET
50 0 50 100
BURTON-DUENKE DAM #5
DAM PLAN

PLATE 3

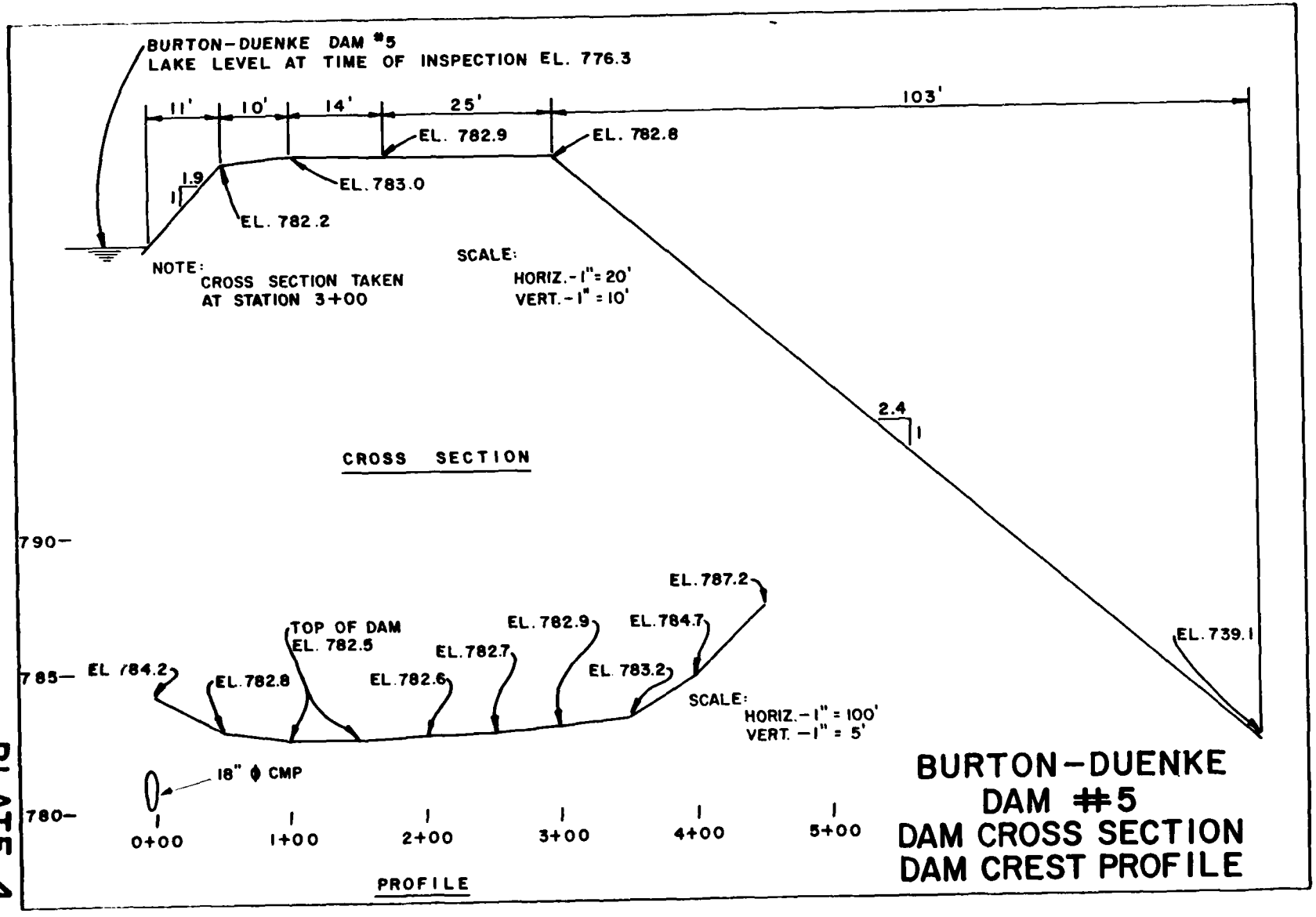


PLATE 4

BURTON-DUENKE DAM #5
DAM CROSS SECTION
DAM CREST PROFILE

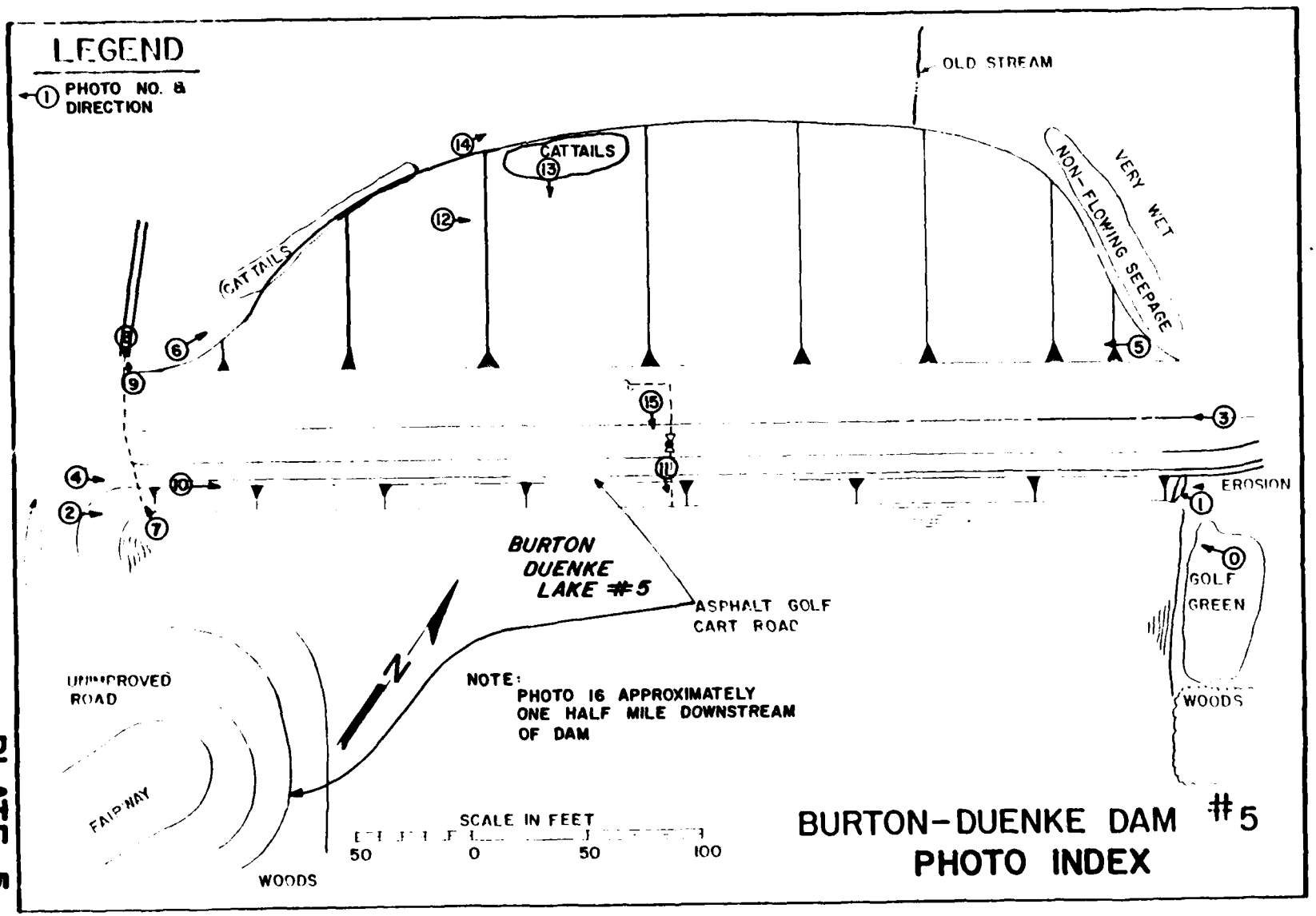

LEGEND
PHOTO NO. & DIRECTION
OLD STREAM
CATTAILS
CATTAILS
VERY WET
NON-FLOWING SEEPAGE
EROSION
BURTON DUENKE LAKE #5
ASPHALT GOLF CART ROAD
GOLF GREEN
WOODS
UNIMPROVED ROAD
FAIRWAY
WOODS
N
NOTE:
PHOTO 16 APPROXIMATELY ONE HALF MILE DOWNSTREAM OF DAM
SCALE IN FEET
50 0 50 100
BURTON-DUENKE DAM #5
PHOTO INDEX

PLATE 5

PHOTO 1 : UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 2 : UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 3 : CREST OF DAM LOOKING WEST

PHOTO 4 : CREST OF DAM LOOKING EAST

PHOTO 5 : DOWNSTREAM FACE OF DAM LOOKING WEST

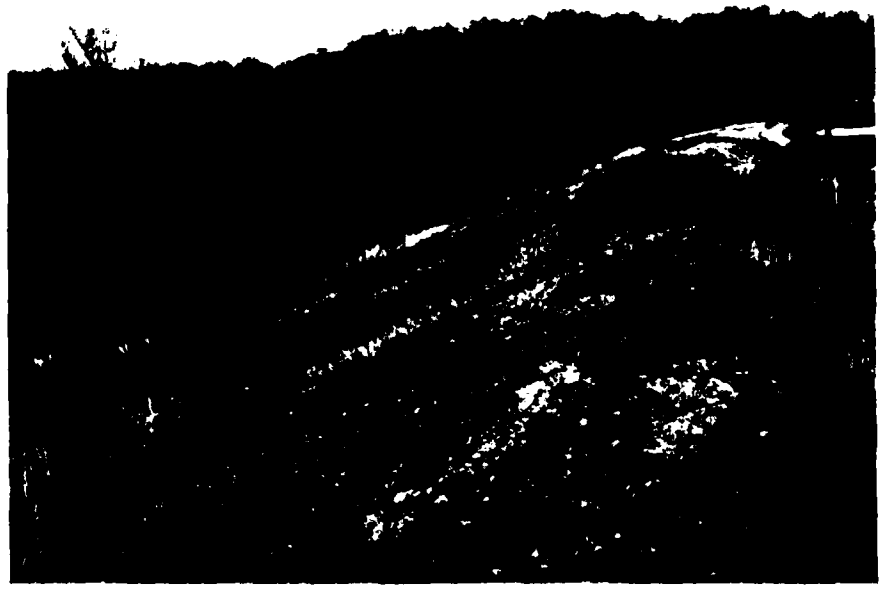


PHOTO 6 : DOWNSTREAM FACE OF DAM LOOKING EAST

PHOTO 7 : SPILLWAY PIPE INLET

PHOTO 8 : SPILLWAY PIPE OUTLET

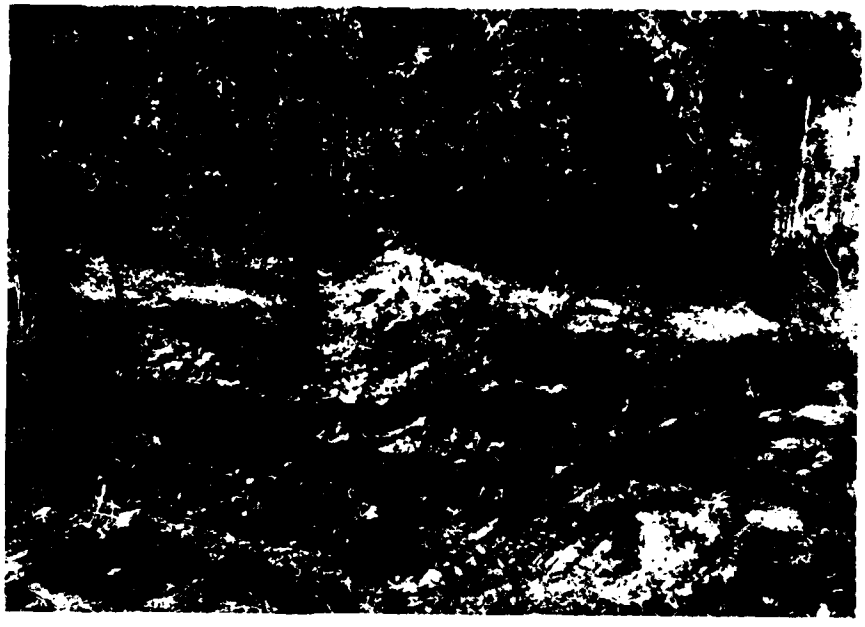


PHOTO 9 : CHANNEL DOWNSTREAM OF SPILLWAY PIPE OUTLET

PHOTO 10: EROSION ALONG UPSTREAM FACE OF DAM

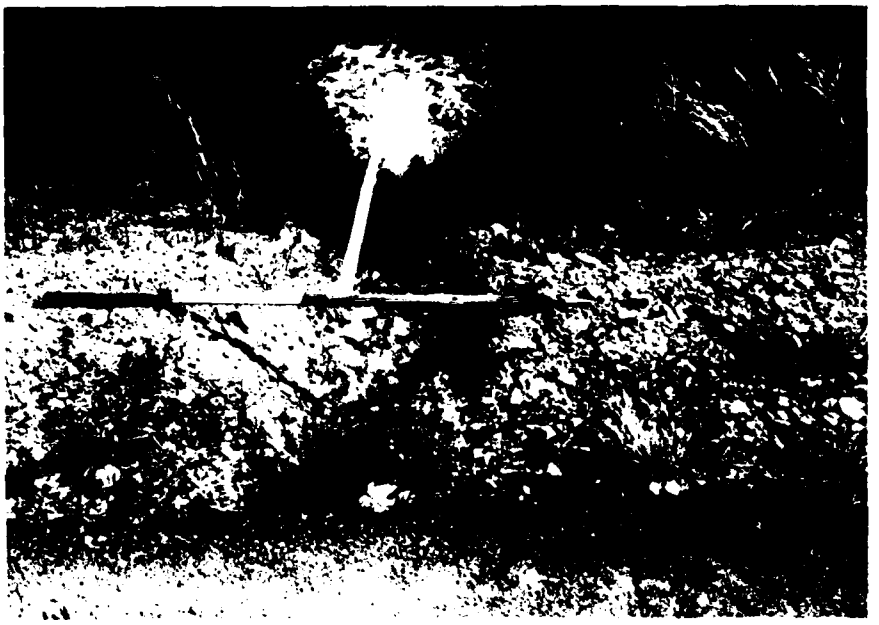


PHOTO 11: EROSION OF UPSTREAM FACE AND WELL DISCHARGE PIPE

PHOTO 12: EROSION ON DOWNSTREAM FACE OF DAM

PHOTO 13: EROSION GULLEY ON DOWNSTREAM SLOPE OF DAM

PHOTO 14: SEEPAGE AREA AT DOWNSTREAM TOE OF DAM

PHOTO 15: LAKE AND WATERSHED VIEWED FROM DAM

PHOTO 16: VALLEY DOWNSTREAM OF DAM

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33) (2). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411 (3). The Jefferson City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoir and spillway.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method (1 and 4). The parameters for the unit hydrograph are shown in Table 1. The formula from which the lag time was derived is noted in Table 1 (5). The lag time was verified by the SCS curve number method (4).

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the Modified Puls Method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the inlet invert elevation of the spillway at elevation 780.0 feet m.s.l. in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (6). The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillway is shown in Table 3. The flow over the crest of the dam was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The flow through the spillway was determined from Hydraulic Charts for the Selection of Highway Culverts (7).

The result of the routing analysis indicates that the spillway will pass a flood equivalent to 15 percent of the PMF without overtopping the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 4.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	28 acres
Length of Watercourse (L)	0.21 miles
Difference in Elevation (H)	80 feet
Time of concentration (T_c)	0.08 hours
Lag Time (L_g)	0.05 hours
Duration (D)	0.6 min. (use 5 minutes)

Time (Min.) *	Discharge (cfs) *
0	0
5	234
10	83
15	19
20	4
25	1

* From HEC-1 computer output

FORMULAS USED:

$$T_c = (11.9 \times L^3/H)^{0.385} \quad (5)$$

$$L_g = 0.6\ T_c$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	33.80	31.92	1.88
50% PMP	24	17.78	15.96	1.82
1% Probability	24	7.44	4.21	3.23

Additional Data:

1) The soil associations in this watershed are Gepp, Bardley, Clarksville, Lebanon, and Doniphan (8).
   62 percent of drainage area in hydrologic soil group B.
   38 percent of drainage area in hydrologic soil group C.
   25 percent of the land use was grassland.
   75 percent of the land use was timberland.
2) SCS Runoff Curve CN = 86 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 72 (AMC II) for the one percent probability flood (4).

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*780.0	2.6	32	0
781.5	3.0	36	6
**782.5	3.3	39	9
783.5	3.5	42	12

*Spillway inlet invert elevation
**Top of dam elevation

The relationships in Table 3 were developed from the Lake Ozark, Missouri. 7.5 minute quadrangle map and the field measurements.

METHOD USED:

The spillway release rates are based on nomographs for a pipe culvert with inlet control (7).

TABLE 4

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam	Duration (Hrs.) Over Top of Dam
-	0	*780.0	32	0	-	-
0.15	121	782.5	39	11	0	1.3
0.50	403	783.2	41	331	0.7	5.5
1.00	806	783.5	42	664	1.0	8.1

* Spillway inlet invert elevation

BIBLIOGRAPHY

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) HMR 33, Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours, U.S. Department of Commerce, NOAA, National Weather Service, 1956.

(3) EM-1110-2-1411, Standard Project Flood Determinations, U.S. Army Corps of Engineers, 26 March 1952.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(6) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(7) U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Charts for the Selection of Highway Culverts, December 1965.

(8) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soils Report for Camden County, Missouri.

(9) Koenig, John W., Missouri Division of Geological Survey, The Stratigraphic Succession in Missouri, 1961.

(10) McCracken, Mary H., Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

FINAL I N-PMF

LISTING OF INPUT DATA DATE 06 MAY 81 TIME 17:18:27

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                                        CARD COLUMNS
          0         1         2         3         4         5         6         7         8
SEQ #  CTS # 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1         * H21  02-2 09457     PMF
     2         A1                MISSOURI DAM INSPECTION PROGRAM
     3         A2            ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
     4         A3                HURT ON-DUENKE DAM #5 - PMF
     5         B    288                  5                                        3
     6         B1     5
     7         J      1        9        1
     8         J10.15  0.20    0.25     0.30     0.35     0.40     0.45     0.50     1.0
     9         K                1                                    1
    10         K1               INFLO. HYDROGRAPH
    11         M      1        20.044                          1.
    12         P       26.     120.     130.
    13         T                .                                   -1       -86
    14         B2      0.048
    15         X                1.
    16         K      1        2                                    1
    17         K1               ROUTE THROUGH DAM
    18         Y                                  1        1
    19         Y1     1                                          -780.0       -1
    20         Y4780.0 781.0   781.5    782.0    782.5    783.0    783.5    784.0    784.5    785.0
    21         Y4786.0 787.0   788.0    790.0
    22         Y5.0    3.0     5.0      8.0      9.5      11.0     12.0     12.7     13.2     14.0
    23         Y516.7  17.5    19.0     20.0
    24         S5.0    0.5     2.6      7.9
    25         SE779.1 740.0   770.0    800.0
    26         $E780.0
    27         $D782.5
    28         SL0.0   115.0   185.0    255.0    315.0    407.0    453.0    477.0    527.0
    29         SV782.5 782.6   782.7    782.9    783.2    784.7    786.0    787.2    791.6
    30         K      99

          0         1         2         3         4         5         6         7         8
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FAC WARNING        C40200104000

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@ASG,T 3.

@ASG,T 4.

@ASG,T 7.

@ASG,T 10.

@ASG,T 11.

@ASG,T 13.

@ASG,T 14.
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PROJECT 69'57

FLOOD HYDROGRAPH PACKAGE - PEP-1 PROGRAM 25/02-21 TIME 17:18:29 CLOSE FILE

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1973
LAST MODIFICATION 01 DEC 82

MISSOURI BASIN INSPECTION PROGRAM
ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
BURTON-DUSHEE DAM FS - PMF

JOB SPECIFICATION

IT	NHR	NMIN	IDAY	IHR	ISEN	METRC	IPLT	IPRT	NSTAN
200	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRATIO= 9 LRTIO= 1

RTIOS= .75 .20 .25 .30 .35 .40 .45 .50 1.00

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	LOCAL
1	2	.04	.00	.04	1.00	.000	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
.00	26.00	101.00	120.00	130.00	.00	.00	.00

LOSS DATA

LOSS	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-80.00	.00	.00

CURVE NO = -80.00 HTNESS = -1.00 EFFECT CN = 85.00

UNIT HYDROGRAPH DATA
TC= .10 LAG= .05

RECESSION DATA
STRTQ= .00 QRCSN= .00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHR IS GT LAG/2)

UNIT HYDROGRAPH 5 END-OF-PERIOD ORDINATES, TC= .00 HOURS, LAG= .05 VOL= 1.00
234. 33. 19. 4. 1.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.22	.21	.01	[illegible]
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.22	.21	.01	69.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.22	.21	.01	[illegible]
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.22	.21	.01	[illegible]
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.22	.21	.01	[illegible]
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.22	.21	.01	72.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.22	.21	.01	[illegible]
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.22	.21	.01	72.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.22	.21	.01	[illegible]
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.22	.21	.01	72.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.22	.21	.01	73.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	[illegible]	[illegible]	.01	7?.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.26	.26	.01	82.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.26	.26	.01	[illegible]
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	[illegible]	.01	[illegible]
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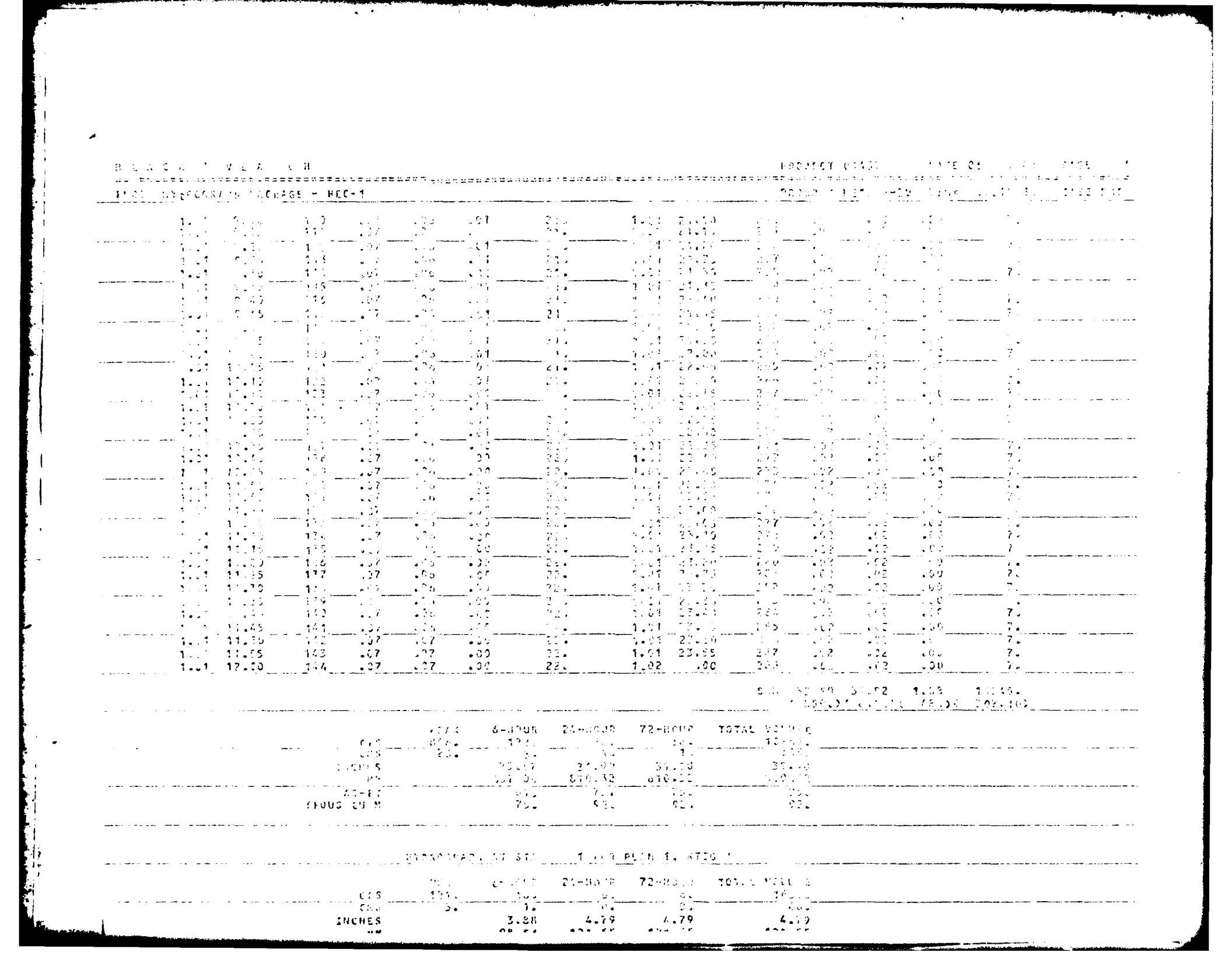
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.26	[illegible]	.01	[illegible]
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.26	.26	.00	[illegible]
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.26	.26	.01	[illegible]
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.26	.26	[illegible]	85.
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.26	.26	.00	8?.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.26	.26	.00	8?.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.26	.26	.00	[illegible]
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.33	.32	.00	[illegible]
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.33	[illegible]	.00	103.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.33	.32	.00	109.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.33	.32	.00	110.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.33	.32	.00	110.
1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.33	.32	.00	110.
1.01	2.30	30	.01	.00	.01	1.	1.01	14.30	174	.33	.32	.00	110.
1.01	2.35	31	.01	.00	.01	1.	1.01	14.35	175	.33	.32	.00	110.
1.01	2.40	32	.01	.00	.01	1.	1.01	14.40	176	.33	.32	.00	111.
1.01	2.45	33	.01	.00	.01	1.	1.01	14.45	177	.33	.32	.00	111.
1.01	2.50	34	.01	.00	.01	1.	1.01	14.50	178	.33	[illegible]	.00	111.
1.01	2.55	35	.01	.00	.01	1.	1.01	14.55	179	.33	.33	.00	111.
1.01	3.00	36	.01	.00	.01	1.	1.01	15.00	180	.33	.33	.00	11?.
1.01	3.05	37	.01	.00	.01	1.	1.01	15.05	181	.20	.20	.00	97.
1.01	3.10	38	.01	.00	.01	1.	1.01	15.10	182	[illegible]	.20	.00	[illegible]
1.01	3.15	39	.01	.00	.01	1.	1.01	15.15	183	[illegible]	.20	.00	[illegible]
1.01	3.20	40	.01	.00	.01	1.	1.01	15.20	184	.50	.49	.00	150.
1.01	3.25	41	.01	.00	.01	1.	1.01	15.25	185	.70	.69	.01	221.
1.01	3.30	42	.01	.00	.01	1.	1.01	15.30	186	1.70	1.69	.01	[illegible]
1.01	3.35	43	.01	.00	.01	1.	1.01	15.35	187	2.79	2.78	.01	456.
1.01	3.40	44	.01	.00	.01	1.	1.01	15.40	188	1.40	1.39	.00	[illegible]
1.01	3.45	45	.01	.00	.01	1.	1.01	15.45	189	.70	[illegible]	.00	315.
1.01	3.50	46	.01	.00	.01	1.	1.01	15.50	190	[illegible]	.70	[illegible]	236.
1.01	3.55	47	.01	.00	.01	2.	1.01	15.55	191	.40	[illegible]	[illegible]	182.
1.01	4.00	48	.01	.00	.01	2.	1.01	16.00	192	.40	.39	[illegible]	141.
1.01	4.05	49	.01	.00	.01	2.	1.01	16.05	193	.31	.31	.00	113.
1.01	4.10	50	.01	.01	.01	2.	1.01	16.10	194	.31	[illegible]	.00	[illegible]
1.01	4.15	51	.01	.01	.01	2.	1.01	16.15	195	.31	.31	.00	10?.
1.01	4.20	52	.01	.01	.01	2.	1.01	16.20	196	.31	.31	.00	[illegible]
[illegible]	[illegible]	53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



```
[illegible]                                                                   [illegible]
==========================================================================================
FLOOD HYDROGRAPH PACKAGE - HEC-1                                  PROGRAM [illegible]

                 AC-FT                 9.     [illegible]      11.    [illegible]
           THOUS CU M                 11.         14.       [illegible]      14.

              HYDROGRAPH AT STA   [illegible] FOR PLAN 1, [illegible]

                          PEAK    6-HOUR    24-HOUR    72-HOUR    TOTAL VOLUME
                  CFS     161.   [illegible] [illegible] [illegible] [illegible]
                  CMS       5.   [illegible] [illegible] [illegible] [illegible]
               INCHES             [illegible] [illegible] [illegible] [illegible]
                   MM             [illegible] [illegible] [illegible] [illegible]
                AC-FT                 12.   [illegible] [illegible] [illegible]
           THOUS CU M                 15.   [illegible] [illegible] [illegible]

              HYDROGRAPH AT STA   [illegible] FOR PLAN 1, [illegible]

                          PEAK    6-HOUR    24-HOUR    72-HOUR    TOTAL VOLUME
                  CFS  [illegible] [illegible] [illegible] [illegible] [illegible]
                  CMS       6.   [illegible] [illegible] [illegible] [illegible]
               INCHES               6.47   [illegible] [illegible] [illegible]
                   MM             [illegible]   202   [illegible] [illegible]
                AC-FT             [illegible] [illegible] [illegible] [illegible]
           THOUS CU M             [illegible] [illegible] [illegible] [illegible]

              HYDROGRAPH AT STA   [illegible] FOR PLAN 1, [illegible]

                          PEAK    6-HOUR    24-HOUR    72-HOUR    TOTAL VOLUME
                  CFS  [illegible] [illegible] [illegible] [illegible] [illegible]
                  CMS       7.   [illegible] [illegible] [illegible] [illegible]
               INCHES             [illegible] [illegible] [illegible] [illegible]
                   MM             [illegible] [illegible] [illegible] [illegible]
                AC-FT             [illegible] [illegible] [illegible] [illegible]
           THOUS CU M             [illegible] [illegible] [illegible] [illegible]

              HYDROGRAPH AT STA   [illegible] FOR PLAN 1, [illegible]

                          PEAK    6-HOUR    24-HOUR    72-HOUR    TOTAL VOLUME
                  CFS  [illegible] [illegible] [illegible] [illegible] [illegible]
                  CMS  [illegible] [illegible] [illegible] [illegible] [illegible]
               INCHES             [illegible] [illegible] [illegible] [illegible]
                   MM             [illegible] [illegible] [illegible] [illegible]
                AC-FT             [illegible] [illegible] [illegible] [illegible]
           THOUS CU M             [illegible] [illegible]      22   [illegible]

              HYDROGRAPH AT STA   [illegible] FOR PLAN 1, [illegible]

                          PEAK    6-HOUR    24-HOUR    72-HOUR    TOTAL VOLUME
```

CFS	323.	49.	17.	15.	13.
CMS	9.	1.	0.	0.	0.
INCHES		10.57	12.73	13.74	13.74
MM		268.52	323.33	348.95	348.95
AC-FT		76.	29.	25.	25.
THOUS CU M		94.	37.	32.	32.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	365.	55.	19.	17.	17.
CMS	10.	2.	1.	0.	0.
INCHES		11.95	14.39	15.53	15.53
MM		303.58	365.59	394.53	394.53
AC-FT		92.	35.	30.	30.
THOUS CU M		114.	43.	37.	37.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	406.	61.	21.	19.	19.
CMS	11.	2.	1.	0.	0.
INCHES		13.28	15.99	17.26	17.26
MM		337.31	406.18	438.37	438.37
AC-FT		102.	39.	34.	34.
THOUS CU M		127.	48.	42.	42.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	606.	122.	38.	36.	36.
CMS	23.	3.	1.	1.	1.
INCHES		25.67	31.49	31.90	31.90
MM		657.65	810.62	810.12	810.12
AC-FT		61.	75.	75.	75.
THOUS CU M		75.	92.	92.	92.

HYDROGRAPH ROUTING

ROUTE THROUGH DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTE - DAM

FLOOD HYDROGRAPH PACKAGE - HEC-1 | PROGRAM H21/02-3? TIME 17:16:34

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.010	.00	1	1	[illegible]	0		[illegible]

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	[illegible]	0	.0.0	.000	.000	-780.	[illegible]

STAGE	[illegible]	[illegible]	781.50	[illegible]	782.50	783.00	783.[illegible]	[illegible]	791.50	[illegible]
	786.00	787.00	[illegible]	790.00						
FLOW	[illegible]	3.[illegible]	[illegible]	[illegible]	9.50	11.00	[illegible]	[illegible]	13.[illegible]	[illegible]
	1[illegible]	17.50	[illegible]	23.00						
SURFACE AREA=	[illegible]	1[illegible].	[illegible]	[illegible]						
CAPACITY=	[illegible]	[illegible]	[illegible]	[illegible]						
ELEVATION=	78[illegible]	[illegible]	[illegible]	800.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
7[illegible]	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
7[illegible]	.5	.0	0.

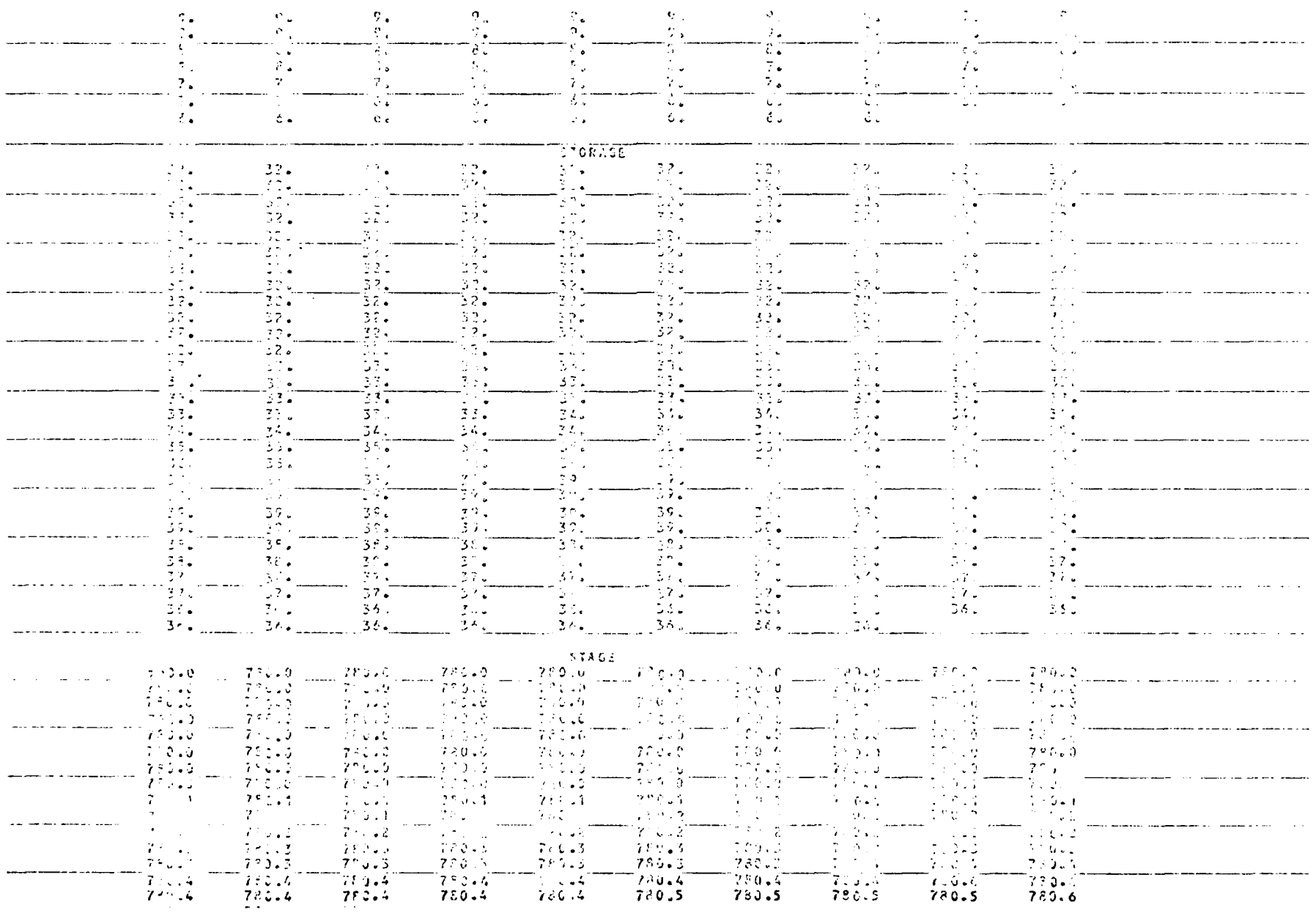
CREST LENGTH AT OR BELOW	0.	115.	1[illegible].	2[illegible].	[illegible]	[illegible]	[illegible]	[illegible]	327.
ELEVATION	782.5	782.6	782.7	782.9	783.[illegible]	[illegible]	[illegible]	787.2	791.[illegible]

STATION [illegible]

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.	9.	9.	9.	10.	10.	10.	10.	10.	10.
10.	10.	10.	11.	11.	11.	11.	10.	10.	10.


STORAGE
STAGE

780.8	780.8	780.9	780.9	781.0	780.9	[illegible]	781.0	781.0	781.1
781.1	781.1	781.1	781.2	781.2	781.2	781.3	[illegible]	781.3	[illegible]
781.4	781.4	[illegible]	[illegible]	781.5	781.6	[illegible]	782.1	782.2	782.3
782.3	782.3	782.3	782.4	782.4	782.4	782.4	[illegible]	782.4	[illegible]
[illegible]	782.5	782.5	782.5	782.5	782.5	782.5	782.5	[illegible]	[illegible]
782.5	782.5	782.5	782.5	782.6	782.6	782.6	782.5	[illegible]	[illegible]
[illegible]	782.3	782.4	[illegible]	782.4	782.4	[illegible]	782.4	[illegible]	782.3
782.2	782.3	[illegible]	782.3	782.2	782.2	782.2	782.2	[illegible]	782.2
782.1	782.1	782.1	782.1	782.1	[illegible]	782.0	782.0	782.0	782.0
782.0	782.0	782.0	781.9	781.9	781.9	781.9	781.9	781.9	[illegible]
781.9	781.8	781.8	781.8	781.8	781.8	781.8	781.7	781.7	781.7
781.7	[illegible]	781.7	781.7	781.7	781.6	781.6	781.6	781.6	781.6
781.6	781.6	781.6	781.6	781.5	781.5	781.5	781.5		

PEAK OUTFLOW IS 11. AT TIME 16.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11.	9.	4.	4.	1000.
CMS	0.	0.	0.	0.	27.
INCHES		1.89	2.[illegible]	2.[illegible]	2.[illegible]
MM		48.13	75.[illegible]	75.05	75.[illegible]
AC-FT		4.	7.	7.	7.
THOUS CU M		5.	9.	9.	9.

STATION 2, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	[illegible]	0.	0.
[illegible]	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	[illegible]	0.	[illegible]	0.
0.	0.	0.	0.	0.	0.	[illegible]	0.	0.	0.
0.	0.	0.	0.	0.	0.	[illegible]	0.	0.	0.
1.	1.	1.	1.	1.	1.	[illegible]	1.	1.	1.
1.	1.	1.	1.	1.	1.	[illegible]	1.	[illegible]	1.
1.	1.	1.	1.	1.	[illegible]	1.	1.	1.	1.
1.	[illegible]	1.	1.	[illegible]	1.	[illegible]	[illegible]	1.	[illegible]
[illegible]	1.	2.	[illegible]	2.	[illegible]	2.	[illegible]	[illegible]	[illegible]
2.	2.	2.	2.	[illegible]	2.	2.	2.	[illegible]	2.
[illegible]	2.	[illegible]	3.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.	4.	[illegible]	4.	[illegible]	4.	4.	[illegible]	[illegible]	5.
5.	[illegible]	6.	6.	[illegible]	5.	5.	6.	[illegible]	7.
[illegible]	7.	7.	8.	[illegible]	[illegible]	9.	[illegible]	[illegible]	12.
[illegible]	[illegible]	23.	23.	[illegible]	24.	[illegible]	[illegible]	22.	[illegible]
21.	[illegible]	21.	21.	21.	20.	[illegible]	19.	18.	17.
17.	17.	17.	17.	17.	17.	[illegible]	[illegible]	[illegible]	15.
10.	10.	9.	9.	9.	9.	9.	9.	[illegible]	9.
9.	[illegible]	9.	9.	9.	9.	9.	9.	9.	9.

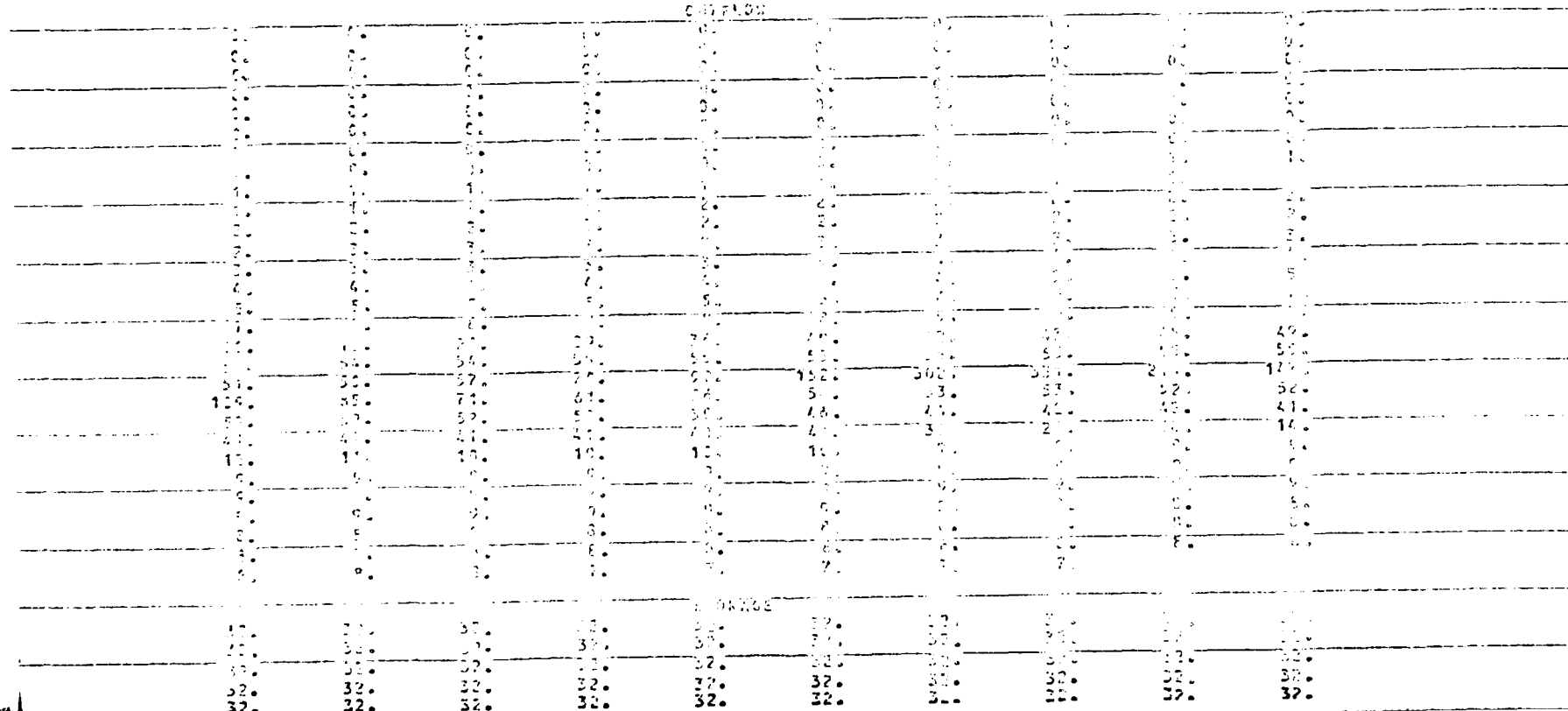
FLOOD HYDROGRAPH PACKAGE - HEC-1

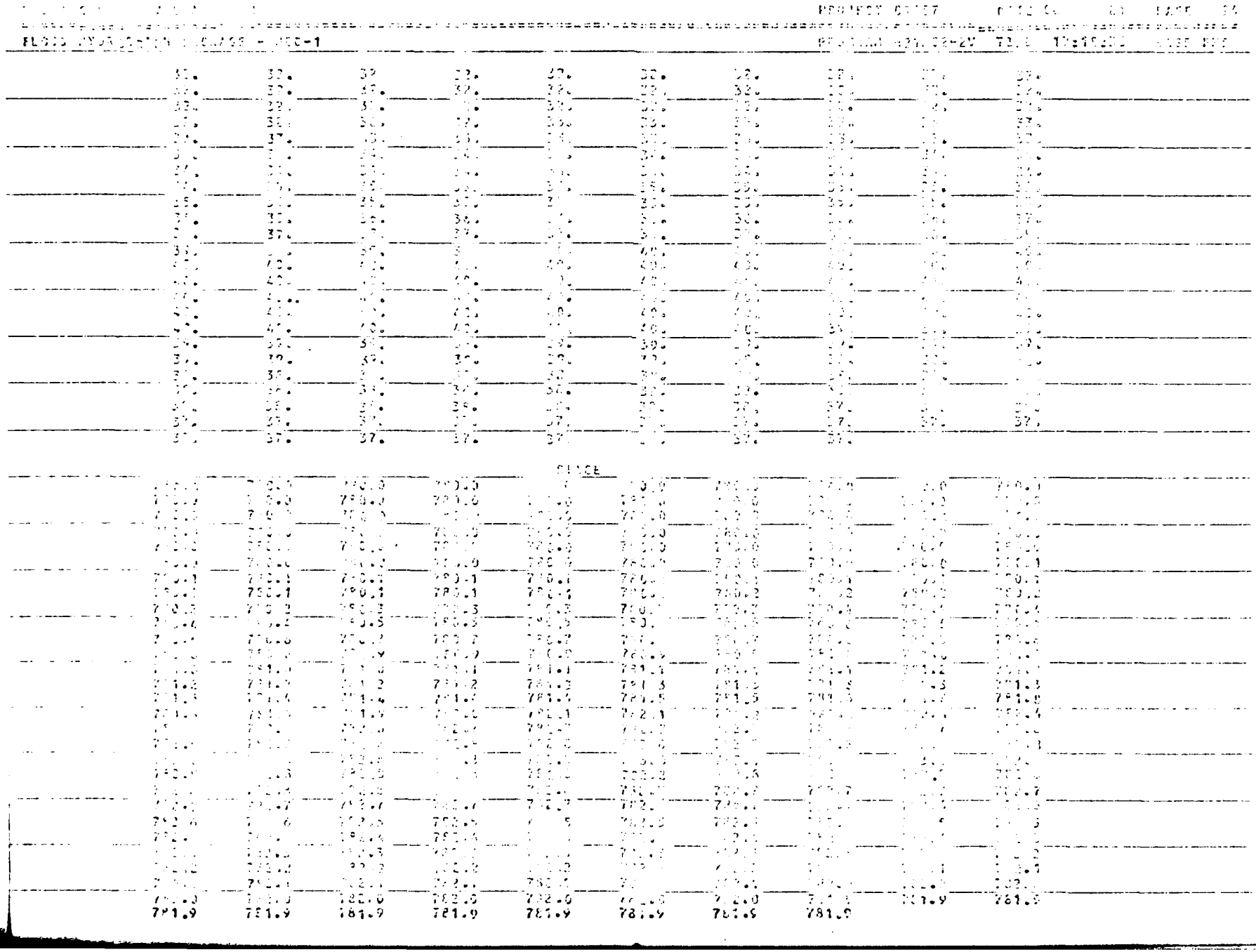
781.9 781.9 781.9 781.9 781.9 781.9 781.9 781.9

PEAK OUTFLOW IS 207. AT TIME 15.67 HOURS

STATION 1, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES





FLOOD HYDROGRAPH PACKAGE - HEC-1

PEAK OUTFLOW IS 331. AT TIME 15.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	331	54.	[illegible]	[illegible]	[illegible]
CMS	9.	[illegible]	[illegible]	[illegible]	[illegible]
INCHES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MM	[illegible]	340.75	340.75	340.75	[illegible]
AC-FT	37.	[illegible]	[illegible]	[illegible]	[illegible]
THOUS CU M	46.	46.	46.	46.	[illegible]

STATION [illegible] (A PLAN 1)

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

[illegible]

STORAGE

[illegible]

[illegible]   PROJECT [illegible]   DATE [illegible]

FLOOD HYDROGRAPH PACKAGE - [illegible]   [illegible]

39.	[illegible]	39.	39.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	39.	[illegible]	[illegible]	[illegible]	39.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	34.	35.	38.	[illegible]	[illegible]	[illegible]
35.	[illegible]	[illegible]	[illegible]	35.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	34.	[illegible]	[illegible]	[illegible]	37.	[illegible]	37.	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	39.	[illegible]	39.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	39.	40.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	40	[illegible]	[illegible]	40.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	40.	40	40.	40.	40.	[illegible]	[illegible]	[illegible]
[illegible]	40.	[illegible]	41.	40.	40.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	41.	40.	40.	41.	40.	[illegible]	[illegible]	41.
[illegible]	[illegible]	41.	40.	40.	40.	40.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	40.	40.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	39.	[illegible]	[illegible]	38.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39.	[illegible]	39.	39.	39.	[illegible]	39.	[illegible]	39.	39.
39.	39.	39.	39.	39.	39.	[illegible]	[illegible]	[illegible]	39.
39.	39.	[illegible]	39.	39.	39.	39.	[illegible]	39.	[illegible]
[illegible]	[illegible]	39.	39.	39.	39.	[illegible]	[illegible]	39.	39.
[illegible]	[illegible]	39.	[illegible]	39.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39.	39.	39.	39.	39.	[illegible]	[illegible]	38.		

STAGE

780.0	[illegible]	780.0	780.0	780.0	780.0	780.0	780.0	[illegible]	[illegible]
780.0	780.0	[illegible]	[illegible]	780.0	780.0	780.0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	780.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	780.0	[illegible]	780.0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	780.0	[illegible]	780.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	780.1	[illegible]	780.1	780.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
780.1	780.1	[illegible]	[illegible]	[illegible]	780.1	[illegible]	[illegible]	[illegible]	[illegible]
780.2	[illegible]	[illegible]	780.2	[illegible]	780.3	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	780.5	780.5	[illegible]	780.6	[illegible]	780.7	[illegible]	[illegible]	[illegible]
[illegible]	780.7	780.9	[illegible]	781.0	781.0	[illegible]	[illegible]	[illegible]	[illegible]
781.2	781.3	781.3	[illegible]	[illegible]	781.4	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	781.7	[illegible]	[illegible]	781.8	[illegible]
781.9	[illegible]	[illegible]	[illegible]	782.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	782.5	[illegible]	[illegible]	782.7	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	782.8	[illegible]	782.8	782.8	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	782.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	782.9	782.9	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	782.6	[illegible]	[illegible]	[illegible]	[illegible]	782.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
782.5	782.5	[illegible]	782.5	782.5	[illegible]	[illegible]	[illegible]	782.5	[illegible]
782.4	[illegible]	[illegible]	[illegible]	782.4	782.4	782.4	[illegible]	[illegible]	[illegible]
782.4	[illegible]	782.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	782.4	782.4	782.4	[illegible]	782.4	[illegible]	[illegible]	[illegible]	782.4
[illegible]	782.3	782.3	782.3	782.3	782.3	[illegible]	782.3		

PEAK OUTFLOW IS [illegible]4. AT TIME 15.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	664.	122.	34.	34.	9905.
CMS	19.	3.	1.	1.	280.
INCHES		25.71	29.08	29.08	29.08
MM		653.12	738.73	738.73	738.73
AC-FT		60.	68.	68.	68.
THOUS CU M		74.	84.	84.	84.

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PEAK FLOW AND STORAGE (END OF PEPIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .15	RATIO 2 .20	RATIO 3 .25	RATIO 4 .30	RATIO 5 .35	RATIO 6 .40	RATIO 7 .45	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	1	.04 (.11)	1	121. (3.42)	161. (4.56)	201. (5.70)	242. (6.84)	282. (7.98)	322. (9.12)	363. (10.26)	403. (11.41)	806. (22.81)
ROUTED TO	2	.04 (.11)	1	11. (.31)	52. (1.47)	145. (4.10)	194. (5.50)	229. (6.48)	263. (7.46)	297. (8.42)	331. (9.39)	664. (18.80)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	780.00	780.00	782.50
STORAGE	32.	32.	39.
OUTFLOW	0.	0.	9.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	782.56	.66	39.	11.	1.33	18.00	.00
.20	782.78	.28	40.	52.	2.92	15.83	.00
.25	782.94	.44	40.	145.	3.17	15.67	.00
.30	783.02	.52	41.	194.	3.75	15.67	.00
.35	783.06	.56	41.	229.	4.25	15.67	.00
.40	783.10	.60	41.	263.	4.75	15.67	.00
.45	783.14	.64	41.	297.	5.17	15.67	.00
.50	783.18	.68	41.	331.	5.50	15.67	.00
1.00	783.47	.97	42.	664.	8.08	15.67	.00

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 L A C K   R   V E A     H                                          PROGRAM  H21/02-2      PAGE    1
 ISTING OF INPUT DATA                                              DATE  05 MAY 81   TIME  17:39:49

                                                  CARD COLUMNS
          0         1         2         3         4         5         6         7         8
EQ #  CTS #12345678901234567890123456789012345678901234567890123456789012345678901234567890

    1         * H21  02-2 09457     PMF
    2         A1                  MISSOURI DAM INSPECTION PROGRAM
    3         A2            ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
    4         A3                  BURTON-DUENKE DAM #5 - PMF
    5         B     288                 5                                                 3
    6         B1      5
    7         J       1         9         1
    8         J10.01  0.02      0.03      0.04      0.05      0.06      0.07      0.50      1.0
    9         K                 1                                                   1
   10         K1                  INFLOW HYDROGRAPH
   11         M       1         20.044                                1.
   12         P         26.       101.      120.      130.
   13         T                                                                 -1      -86
   14         W2      0.048
   15         X                   1.
   16         K       1         2                                                 1
   17         K1                  ROUTE THROUGH DAM
   18         Y                                     1         1
   19         Y1        1                                                   780.0       -1
   20         Y4780.0 781.0     781.5     782.0     782.5     783.0     783.5     784.0     784.5     785.0
   21         Y4786.0 787.0     788.0     790.0
   22         Y50.0     3.0       5.6       8.0       9.5      11.0      12.0      12.7      13.2      14.0
   23         Y516.0    17.5      19.0      20.0
   24         SA0.0     0.5       2.6       7.9
   25         SE739.1 760.0     780.0     800.0
   26         SA780.0
   27         SD782.5
   28         SL0.0     115.0     185.0     255.0     315.0     407.0     453.0     477.0     527.0
   29         SV782.5 782.6     782.7     782.9     783.2     784.7     786.0     787.2     791.6
   30         K       99
   31         * H21  02-2 09457     100
   32         A1                  MISSOURI DAM INSPECTION PROGRAM
   33         A2            ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
   34         A3                  BURTON-DUENKE DAM #5 - 100YR
   35         B     288                 5                                                 3
   36         B1      3
   37         K                 1                                                   1
   38         K1                  INFLOW HYDROGRAPH
   39         M       0         20.044                                1.
   40         O     288   7.444                       DA #     .50
   41         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   42         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   43         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   44         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   45         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   46         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   47         O1    .007      .007      .007      .007      .007      .007      .007      .007      .007      .007
   48         O1    .007      .007      .013      .013      .013      .013      .013      .013      .013      .013
   49         O1    .013      .013      .013      .013      .013      .013      .013      .013      .013      .013
   50         O1    .013      .013      .013      .013      .013      .013      .013      .013      .013      .013

          0         1         2         3         4         5         6         7         8
EQ #  CTS #12345678901234567890123456789012345678901234567890123456789012345678901234567890
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LISTING OF INPUT DATA DATE 05 MAY 81 TIME 17:39:49

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                 C        1        2        3        4        5        6        7        8
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   51         G1  .013    .013    .013    .013    .013    .013    .013    .013    .026    .026
   52         01  .026    .026    .026    .026    .026    .026    .026    .026    .026    .026
   53         01  .026    .026    .026    .026    .026    .026    .029    .029    .029    .029
   54         01  .029    .029    .081    .081    .081    .081    .081    .081    .123    .124
   55         01  .124    .236    .236    .551    .838    .783    .236    .124    .124    .123
   56         01  .081    .081    .081    .081    .081    .081    .029    .029    .029    .029
   57         01  .029    .029    .026    .026    .026    .026    .026    .026    .026    .026
   58         01  .026    .026    .026    .026    .026    .026    .026    .026    .026    .026
   59         G1  .013    .013    .013    .013    .013    .013    .013    .013    .013    .013
   60         G1  .013    .013    .013    .013    .013    .013    .013    .013    .013    .013
   61         01  .013    .013    .013    .013    .013    .013    .013    .013    .013    .013
   62         01  .013    .013    .013    .013    .013    .013    .007    .007    .007    .007
   63         01  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   64         G1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   65         01  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   66         01  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   67         G1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   68         01  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
   69         01  .007    .007    .007    .007    .007    .007    .007    .007
   70         T                                                    -1      -72
   71         W2      0.048
   72         X               1.
   73         K    1       2                                       1
   74         K1              ROUTE THROUGH DAM
   75         Y                                       1       1
   76         Y1   1                                                  -780.0      -1
   77         Y4780.0 781.0   781.5   782.0   782.5   783.0   783.5   784.0   784.5   785.0
   78         Y4786.0 787.0   788.0   790.0
   79         Y50.0   3.0     5.6     8.0     9.5     11.0    12.0    12.7    13.2    14.0
   80         Y516.0  17.5    19.0    20.0
   81         $A0.0   0.5     2.6     7.9
   82         $E739.1 760.0   780.0   800.0
   83         $778.0
   84         $D782.5
   85         $L0.0   115.0   185.0   255.0   315.0   407.0   453.0   477.0   527.0
   86         $V782.5 782.6   782.7   782.9   783.2   784.7   786.0   787.2   791.6
   87         K   99
   88         * H21  02-2 09457      19
   89         A1              MISSOURI DAM INSPECTION PROGRAM
   90         A2          ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
   91         A3              BURTON-DUENKE DAM #5 - 10YR
   92         B    288                5                                          3
   93         B1     3
   94         K                1                                       1
   95         K1              INFLOW HYDROGRAPH
   96         W       C       20.044                  1.
   97         G    288   5.212                  DA #    .50
   98         01  .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
   99         01  .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
  100         01  .005    .005    .005    .005    .005    .005    .005    .005    .005    .005

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SEQ #  CTS #  12345678901234567890123456789012345678901234567890123456789012345678901234567890
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1.01	23.00	276	23.00	2.	4.	35.	781.3
1.01	23.05	277	23.08	2.	4.	35.	781.3
1.01	23.10	278	23.17	2.	4.	35.	781.3
1.01	23.15	279	23.25	2.	4.	35.	781.3
1.01	23.20	280	23.33	2.	4.	35.	781.3
1.01	23.25	281	23.42	2.	4.	35.	781.3
1.01	23.30	282	23.50	2.	4.	35.	781.2
1.01	23.35	283	23.58	2.	4.	35.	781.2
1.01	23.40	284	23.67	2.	4.	35.	781.2
1.01	23.45	285	23.75	2.	4.	35.	781.2
1.01	23.50	286	23.83	2.	4.	35.	781.2
1.01	23.55	287	23.92	2.	4.	35.	781.2
1.02	.00	288	24.00	2.	4.	35.	781.2

PEAK OUTFLOW IS 8. AT TIME 13.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8.	8.	3.	3.	953.
CMS	0.	0.	0.	0.	27.
INCHES		1.65	2.80	2.80	2.80
MM		41.84	71.05	71.05	71.05
AC-FT		4.	7.	7.	7.
THOUS CU M		5.	8.	8.	8.

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RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	168.	17.	5.	5.	.04
	(	4.76)(	.47)(	.14)(	.14)(	.11)
ROLTED TO	2	8.	8.	3.	3.	.04
	(	.24)(	.22)(	.09)(	.09)(	.11)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	780.00	780.00	782.50
STORAGE	32.	32.	39.
OUTFLOW	0.	0.	9.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
100-YR.	1.00	782.11	.00	38.	8.	.00	13.25	.00


DATE
ILME